Haiti technical cold chain dry run

Applying distributed ledger technology to connect Haitian mango and avocado producers to foreign markets

Rene Oostewechel, Yves-Laurent Régis, Jan Brouwers with Jan Vogels, Anton Smeenk and Xin-Ying Ren

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Preface

This report provides the technical results of a Dry Run cold chain test on mango and avocado, analysing data of the cold chain from harvest in Haiti till arrival in the US, Canada and The Netherlands. The cultivation and sales of these fruits is a major contributor to the income of the poorest people of Haiti. However, studies show a lack of competitiveness caused by a poor performance of the supply chain logistics and inefficiency due to lack of structured (micro)orchards established according to an agronomic optimal plan. In particular post-harvest losses and quality decay throughout the supply chain are problems to be tackled to increase the income of the farmers and other stakeholders in this supply chain. To resolve these issues expertise in logistic design, cost analysis, facility design, packaging, and optimal product conditions is required.

The Haitian Ministry of Trade and Industry (MCI) through the Business Development and Investment Project (BDI) undertakes activities to support regional development and sustainable economic growth in Haiti. We are grateful to the staff of MCI, with leadership of Michel-Ange Pantal, and the staff of the WBG in charge of the BDI project, especially Emiliano Duch, Maria Deborah Kim and Jean Emmanuel Desmornes. They have provided a wealth of information and connected the mission members to key stakeholders.

We also would like to thank all stakeholders met during the field mission in Haiti especially the mango and avocado farmers participating in the trial and the Perry family for providing their facilities and sharing their ideas about potential improvements of the fruit value chains. We are also very grateful to the support staff of the MCI office that assured a seamless logistics during the mission.

This report was financed by the Ministry of Economy and Finance of the Republic of Haiti within the framework of a World Bank loan. The study, whose results are included in this report, has been conducted independently by specialists of Wageningen Food & Biobased Research (WFBR), part of Wageningen University and Research (WUR), The Netherlands.

All statements and arguments provided by this report are the views of the team members of Wageningen UR; in no way may the WB, MCI or any other partner involved in this study be held accountable for the content of this report. The team has tried to be as complete as possible. Any errors in the text are the responsibility of the team alone and not the responsibility of the people we have met during our mission to Haiti.

Summary

This report provides the technical results of a dry run transporting mangoes and avocados from Haiti to the US, Canada and The Netherlands. For both fruits, temperature has been registered from the moment of harvest till arrival at all destinations. Also logistical data related to the planning and preparation of the test, time needed for each step, and quality of fruits has been analysed.

After the introduction chapter, technical data are provided for both mango and avocado in the next two chapters, with a concluding last chapter afterwards that provides overall analysis, lessons learned and recommendations. Use of the QR codes has allowed a transparent and digital process where all chain partners have open access to all information.

The report presents a block chain test at limited level and actual implementation and scaling of block chain procedures might still need refinement like the longer ripening and/or storage before retail distribution.

Abbreviations

BDI	Business Development and Investment Project
DR	Dominican Republic
MARNDR	Ministère de l'Agriculture, des Ressources Naturelles et du Développement Rural
MCI	Ministère du Commerce et de l'Industrie
MSME	Micro, small and medium-sized enterprises
PDAI	Projet de Développement des Affaires et des Investissements
PPP	Public - Private Partnership
QC	Quality Control
SAE	Enterprise Support Service
SME	Small and Medium Size Enterprises
SP	Service Provider
SPS	Sanitary and Phyto-sanitary Standards
USDA	U.S. Department of Agriculture
WB	World Bank
WFBR	Wageningen Food & Biobased Research (part of WUR)
WUR	Wageningen University & Research

1 Introduction

1.1 Introduction to the project

The Ministry of Trade and Industry (MCI) through the Business Development and Investment Project (PDAI) is undertaking activities to support regional development and sustainable economic growth in Haiti. This project uses a value chain approach to promote the development of the country by establishing functional linkages between micro, small and medium-sized enterprises (MSMEs), which generates benefits for all producers and end consumers. The MCI intends to use the counterpart funds mechanism of the PDAI project to finance either partially or totally the training, technical assistance or common services that SMEs currently need to allocate or increase the value of products and, as a result, access markets where they can maximise their profits and thus increase their income.

The cultivation and sale of mangoes and avocados is a generator of employment in the poorest areas of the country and contributes to nearly 40% of the income of this category of people. The value chain analysis was carried out by the MCI Business Support Services (SAE) of the MCI established in the regions. It is in this exercise that the SAEs operating in the Artibonite and the Central Plateau and which are working with producers in these areas have concluded that the mango and avocado industry needs to be improved so that Micro, Small and Medium Enterprises (MSMEs) become more competitive and generate more revenue.

Mangoes and avocados are perishable products and as such may be damaged and become unfit for consumption due to undesirable variations (and levels) in temperature, thus exposing producers to considerable losses. And, in order to achieve the reduction of these post-seasonal losses and, at the same time, to improve the quality of these fruits, the mango and avocado industry in Haiti requires suitable cold chain logistics that enables the control of the process of ripening fruit and to have access to more attractive markets, like the US.

The Haitian government has selected as consultant for the project Wageningen Food & Biobased Research (WFBR), see contract. WFBR already has concluded a scoping study that includes an analysis of the avocado and mango sector in Haiti (WB report ACS22611; 2017) and a study detailing the technical logistics facilities needed to upgrade the cold chain for fruits in Haiti (WFBR 1804; 2018). These reports provide a basis for the present project, which will operationalise the cold chain design for two regions in Haiti.

MCI SAEs teams are currently working with a group of more than 100 mango producers in Artibonite and avocado producers in the Central Plateau that are willing to use cold chain logistics services to access better market opportunities in the US. For the time being, the annual production by target groups of farmers is estimated at 3.152.000 kg mango and 893.371 kg of avocados. However, beyond the 60 targeted mango smallholders and 56 targeted avocado smallholders producers, there is scope for greater demand for cold chain logistics services in Haiti.

Production of Francis Mango is estimated at about 155,756 ton per year. Production of the total of other varieties is 992,047 ton per year (2014). Francis: for export, mainly grown in Artibonite (in Gros Morne in particular) where 68,905 MT is harvested which is 44% of the annual Mango Francis production volume (2014). Export statistics for avocado show only export of 8 MT of avocados to the USA in 2015. In addition there is an informal export flow to the Dominican Republic that is estimated at 10,000 MT.

Waste figures up to 70% are reported. Fruits need to be harvested correctly, at the right maturity stage and cooled within two days to avoid losses. The main problems in the two Haitian fruit chains are observed in planning capacity and at harvest. There is a need for a more tight schedule with a constant flow of produce from the orchards to the pack station, processing at the pack station, and transport from pack station to Port au Prince and from Port au Prince to Miami. The new cold chain logistics services represent a major opportunity for producers in this sector and others in their quest to access more promising markets.

Relevant impact of improving the cold chain: As for direct job creation, in total, the mango value chain is supported by at least 150,000 economic agents (e.g., producers, intermediaries, transporters, workers, and exporters) [ref 1 Haiti I report]. The number of farm households involved in mango production in Haiti is estimated from 200.000 to 300.000. As for the variety Francis, the number of farms in the main farming areas is estimated at 30.000 to 60.000. It is estimated that approximately 230.000 people are directly involved in mango production for export (WB report ACS22611; 2017).

The overall purpose of the project is to begin the technical design of the cold chain logistics services for the export of mangoes and avocados from the Artibonite and the Central Plateau to the United States. The first part of the project will be the description of services and technical specifications which will be used in the tender documents. The second part of the project is supervision of the firm which will win the tender for the supply of the cold chain service.

This present supporting sub-project has started in November 2017 with the technical design of the cold chain (see report WFBR 1804). During this start up mission the idea was born to add a dry run test already during Phase 1. The tender procedure, selecting the winning consortium, contracting the winning consortium and starting up Phase II will probably take till mid/end 2018. A Dry Run in the growing season will allow to test the block chain design and prepare the tender in a more realistic way.

1.2 Purpose and objectives

The overall purpose of the technical cold chain test was to pre-test the design of the respective block chains for mango and avocado and improve preparations for the upcoming tender. Objectives were the following:

1. Improve and test the planning procedures for handling mango and avocado harvest, transport to pack station, processing and preparing for export at Port au Prince;
2. Attention for; product sourcing. Local transport, conditioning, treatments, packaging, transit , quality observations, variation in quality/ maturity at harvest on shelf life and quality at arrival.
3. Special focus on fruit-flesh temperature development through each step of the value chain as well as duration of each step in the chain;
4. Implement and monitor closely procedures from harvest till transport at Port au Prince of a small sample;
5. Costs estimates of each step in the chain;
6. Analyse results with SAE and farmers, formulate lessons learned and recommendations;
7. Report on results with specific recommendations for tender formulation and supervision of implementing service provider in Phase II;
8. Advise on the implementation requirements for block chain (Distributed Ledger Technology) tender specifically.

1.3 Methodology

This report summarises a concrete test analysing what happens if mango and avocado fruits are harvested and exported, while trying to follow technical requirements for an optimal cold chain. The technical cold chain test prepared, implemented, reviewed and reported on the different block chain steps during a small scale test, producing just several carton boxes of mangoes and avocados. To be able to trace two farmers were selected for mango and two farmers for avocado. Each farmer should be able to provide 4 boxes, each box averages 8/9 fruits, so at least 35 fruits/farmer.

The test also includes a traceability test by adding QR codes. Fruits were checked on temperature at harvest and a logger added for all boxes, starting temperature registration as of harvest until arrival at final destination. Scanning QR codes allows to check on where the fruits were harvested (tracing back to the original farmer) and on temperature during transport.

This was a test to see what happens if one tries to respect technical cooling prescriptions in a fresh chain with destination US, Canada and The Netherlands. Not all potential technical data that can be uploaded as block chain information were prepared and applied, but the selected data that was uploaded for the trial gives a good indication of the possibilities. It also allows to see where and how the cold chain can be improved. The test also checked a few assumptions that we had at the start like for example that logistics hampering the fast cooling for mangoes, do not limit the possibility to export good quality as long as the rest of the cold chain is respected. This leads to a conclusion if they were confirmed or had to be adapted.

The test was not done according to a real shipment (in a reefer) including hot water treatment. This is because the test concerned only 9 boxes, and air freight was chosen. Standard carton mango export cartons were used, but due to shipment via DHL, the fruits needed to be stabilised preventing any air circulation during transport. Thirdly, also the distribution in the country of destination was not according a real large export shipment that will be received by an importer that has the facilities to maintain the cold chain. Especially the cold chain effects could therefore not be tested accurately and partly a home refrigerator was used to store the fruits, due to lack of professional cold storage facilities for this size of test. The tests gave information on several issues, including the difficulties and dangers of harvest, time consumption of harvest and (non) accessibility of groves. Also with regard to information gathering and the possibilities for block chain design, the test provided valuable information resulting in the possibility to scan a box with a mobile phone available to any consumer, showing the fruit history combined with the name and photograph of the farmer.

The mango fruits from two farmers were not mixed in the box. Due to the size of the test (one box per fruit per destination) the fruits sent to Miami and Washington came from 1 farmer and were less mature at harvest than those sent to Toronto and Wageningen. The difference was clear however.

Avocadoes were cooled directly after harvest whereas mangoes were transported in an air-conditioned car with the purpose to cool them just to be below 30 C. This resembles the real situation whereby temperature rise in mango needs to be avoided after harvest, but logistics and the hot water treatment that needs to follow, impede the strict cooling directly after harvest. For Avocadoes there is no need for hot water treatment and cooling directly after harvest is more important which was therefore arranged.

1.4 Preparation and organisation technical Dry Run test

A service provider in Port au Prince was identified willing to receive the fruits and store them in their cooling facility, while waiting for shipment. The Perry Family kindly agreed to participate in the test, allowed access to their facilities and provided crates for harvesting and packing material for sending the fruits. They also agreed to have two loggers registration their current procedures from tree till arrival in the US, which will allow to have a comparison with the usual current procedure for mangoes (control group).

Shipment from Haiti was arranged via DHL. DHL facilitated a check on proper transport material of the fruit boxes, obtaining the required phyto-sanitary and other custom documents. Fruits were scheduled to be transported on Thursday 17 May to Miami via Air Freight, afterwards to Cincinnati, and afterwards by air freight to several addresses in the US, Canada and Europe.

Loggers placed in each of the boxes needed to be recovered after arrival at final destination in order to be able to use the data. Each box included an instruction letter allowing to share the data.

MCI prepared a letter to allow the Wageningen team to import technical equipment for testing temperature (loggers, individual fruit packing material, QR label printing machine, thermometer).

MCI also supervised the two SAE teams in preparation and implementation of the trial and supported logistical transport during the technical cold chain test. An additional element was the interest expressed by the Minister of Commerce & Industry to join part of the Dry Run. He was able to join the trial with the first mango producer in Gros Morne. The event provided additional media exposure and allowed to produce communication footage for the project.

2 Avocado test

2.1 Execution of the test

On Tuesday 15 May, the avocadoes were harvested. The MCI SAE team Centre prepared the test by organising the harvest to be conducted at the premises of two farmers in the region 'Centre'. The season just started so only a few avocado trees started to have mature fruits. It was difficult to find trees with mature fruits.

The fruits were collected at a the following two farmers:

1 Ronel Saint-Louis	+509 4043 4393	Carrefour Corossol	Lascahobas	Centre
2 Dieumercie Julien	+509 4888 5840	Cerecit	Lascahobas	Centre

The trees were high (approximately between 12 and 15 meter) and harvesting was difficult and time consuming.

Photograph 1: Avocado harvest impression

Farmer 1 had a tree close to his house at the main road and it took some 25 minutes to harvest 50 fruits. His fruits were mature, yet not ripe, with a smooth skin, still firm and hard. Farmer 2, however, had one tree at a 20-minute walk up-hill on a rather steep path. It took in total an hour and a half to collect the 50 fruits.

The collected fruits from farmer 2 were ripe already and less smooth. They were not all nicely smooth and some stains were visible on the skin of some of the fruits. Inside they looked good, green and firm but some had a loose pit.

The outside temperature at harvest was 29.3 C in the shade but the fruit temperature measured ranged from 32.8 to 33.9 C. (91.5 F)

The fruits were wrapped in a protection sleeve and a total of 4 temperature loggers were placed in the crates. The crates also got a QR code to be able to identify the grower throughout the chain. The time between the start of the harvest and the placing of the fruit in the cold box in the car was between 20 minutes and 1 hour 50 minutes.

Photograph 2: Avocado temperature check



For transportation, a freezer was put in a pick-up truck. This box was cooled down to 7.4 C and then disconnected. At this temperature the avocados were transported to Port au Prince.

Photograph 3: Avocado transport and packing


After an transport time of 2 hours, in small plastic field crates, the fruits were put in a cold storage at the premises of Perry Export in Port au Prince on Tuesday evening.

On Thursday morning the crates were taken from the storage and the fruits were selected and put in carton boxes, each labelled with QR code and a temperature logger was put in each of the boxes. Afterwards they were stored at the Hotel cold store in preparation for shipment via DHL on Thursday afternoon.

A phytosanitary document and pro-forma invoice were prepared and in the afternoon the boxes were send via DHL office in Port au Prince, to leave for an evening flight to Miami.

Photograph 4: Avocado documents

On Monday 21 May, the boxes were delivered at the addresses in Washington, Toronto and Miami; and on 22 May in Wageningen.

Further testing after arrival was foreseen as follows:

- 3 fruits left to ripen on arrival
- 3 left to ripen 1 week after arrival
- 3 left to ripen 2 weeks after arrival
- 3 left to ripen 3 weeks after arrival

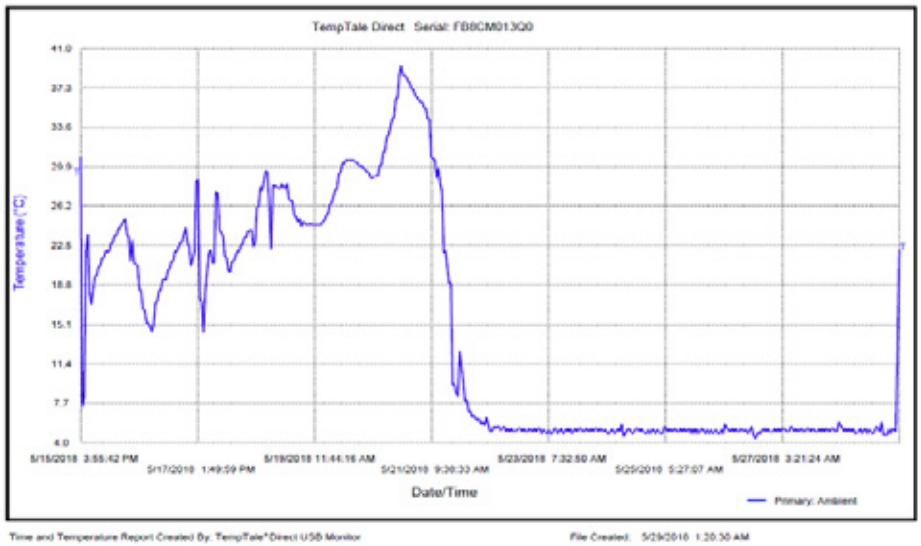
2.2 Data collected

Box 1, Avocado:

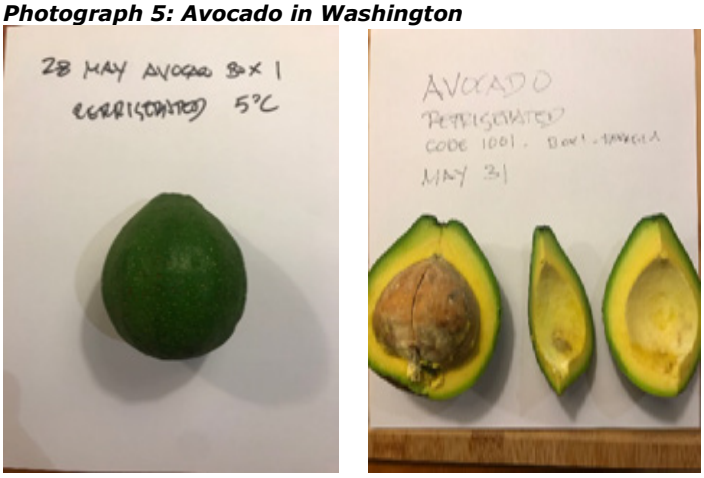
Figure 1: Label box 1 avocado

code: 1001
recipient: Washington, E. Duch

Graph 1: Temperature graph Box 1 avocado



Photograph 5: Avocado in Washington



Despite the extremely high temperatures during transport from Port au Prince to the US, especially during delivery, the avocados from farmer 1 kept well and were still marketable 16 days after harvest. The ripeness stage at harvest was of much influence and is a critical factor when harvesting: only pick those fruits that are mature and ready for ripening.

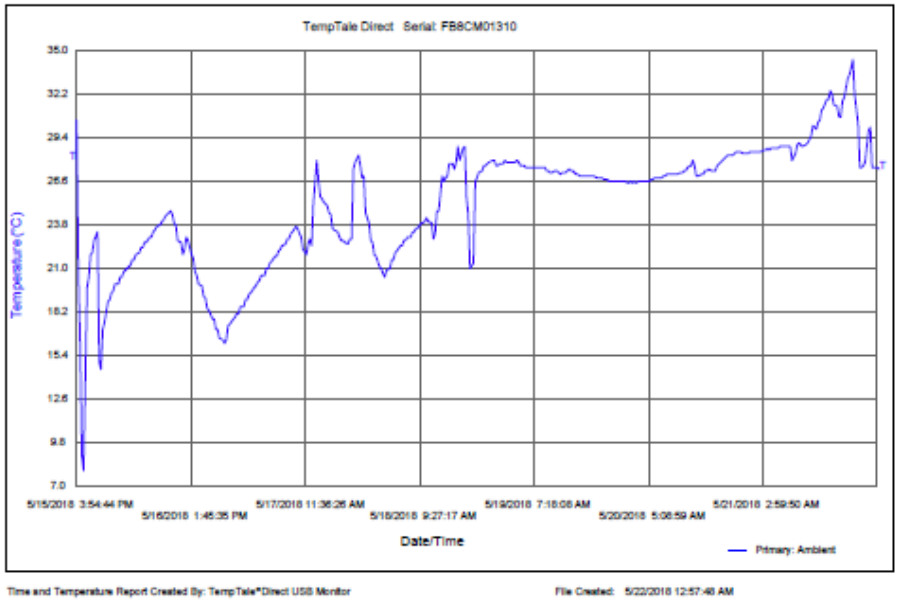
Box 2, Avocado:

Figure 2: Label box 2 avocado

Farmer 1 BOX 2 , Avocado, Las Cahobas (Centre)15-05-2018

code:1002
recipient: Miami. G. Ferrer

Graph 2: Temperature graph Box 2 avocado



Avocados from farmer 1 arrived in Miami in reasonable shape but were clearly more ripe than the mangoes that were send at the same time.

Photograph 6: Avocado in Miami upon arrival

This is how an avocado looked like when it was opened and tasted upon arrival (Photograph 6). That was the same date that they arrived, on May 21, 2018. Taste was appreciated as delicious. Texture was good and the taste buttery according to Mw Ferrer and her daughter.

After that all the avocados were kept inside the fridge. But even staying in the fridge they got ripe and this is how one of them looked like 5 days later, on May 26, 2018. The taste was good though.

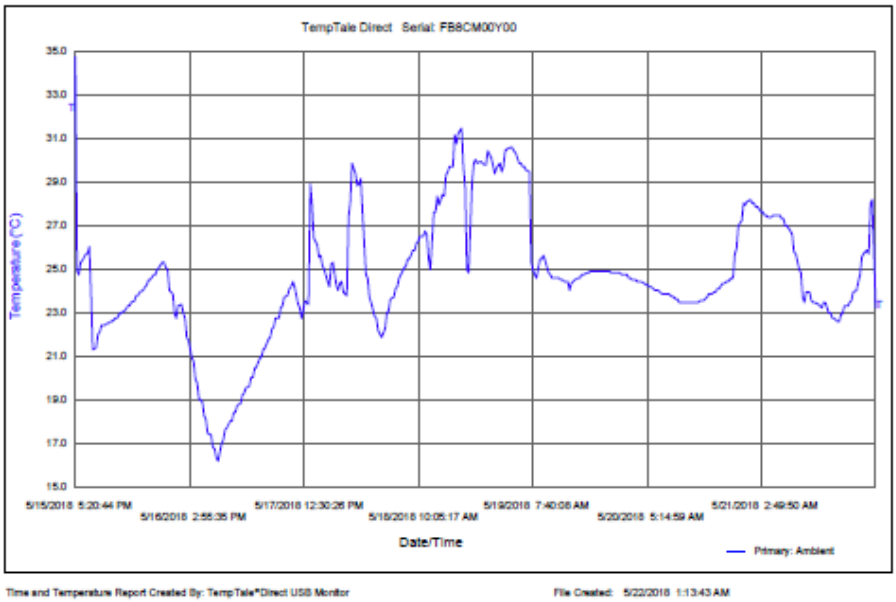
Photograph 7: Avocado in Miami after 5 days

Box 3, Avocado:

Figure 3: Label box 3 avocado

code: 1003
recipient: Toronto, S. Kim

Graph 3: Temperature graph Box 3 avocado



Of 8 avocados, 7 had liquefied and burst out of the bottoms upon arrival in Toronto.
1 intact avocado survived - when shaken the pit was quite loose inside and rattled around - tasted fine. There were no black streaks or black dots in the flesh, no bugs or anything else inside the box - but everything was soaked in smelly avocado juice.

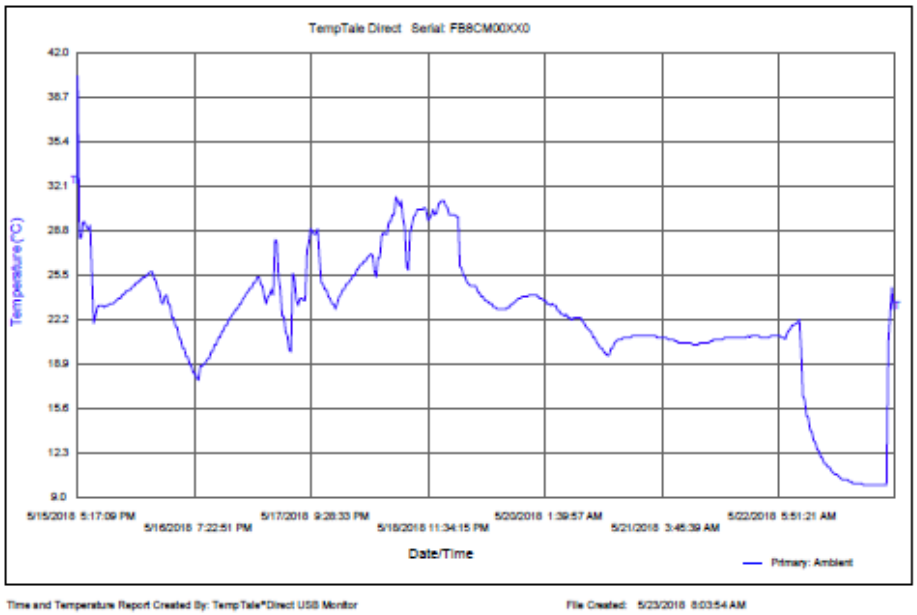
The source of the avocado, farmer 2, is the main reason for the difference in arrival compared to Miami and Washington.

Box 4, Avocado:

Figure 4: Label box 4 avocado

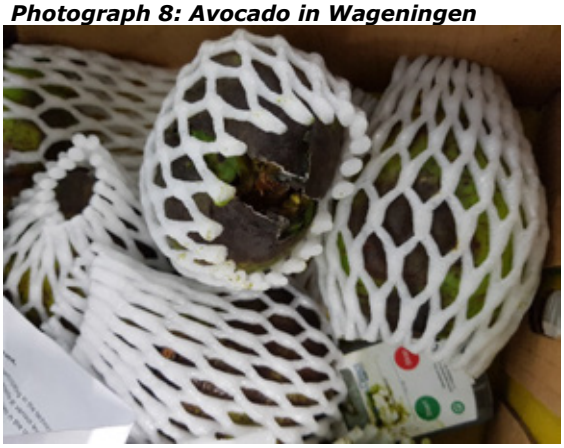
code: 1004
recipient: Wageningen, R. Oostewechel

Graph 4: Temperature graph Box 4 avocado



Avocadoes from Farmer 2 arrived in Wageningen on 22 May and were immediately stored in a cold store. Most were over-ripe and past their shelf life. Some were still eatable and the taste was good but appearance not. The same source as avocadoes in Toronto lead to the same conclusion: fruits at harvest were too ripe, in combination with the high transport temperatures reduced the quality to unacceptable.

Photograph 8: Avocado in Wageningen



Data for avocado were registered in order to be able to start working on a block chain model, later to be extended. The following data was registered between harvest and shipment:

- A QR-code was made for each box to be shipped.
- Temperatures were registered as well as shipping time.
- Also some costs have been registered in order to collect data that can be used in the development of a digital system that includes visibility of costs in all levels of the chain.

3 Mango test

3.1 Execution of the test

On Wednesday 16 May, the mangoes were harvested. For this test, the press was invited and the minister of Trade and Industry, Mr. Pierre Marie Du Meny travelled to Gros Marne to witness the mango test.

Photograph 9: Film shoot and discussion WB (E. Duch/ M. Kim) and minister (P. du Meny)

Very important in the mango test was the selection of fruits in their right moment of development. Mature but not ripe. One of the main ways to determine the ripeness is a colour scheme as follows:

Photograph 10: Colour ripeness scale Francis mango

Internal flesh color development (1 to 5 scale; left to right) for Francis mango

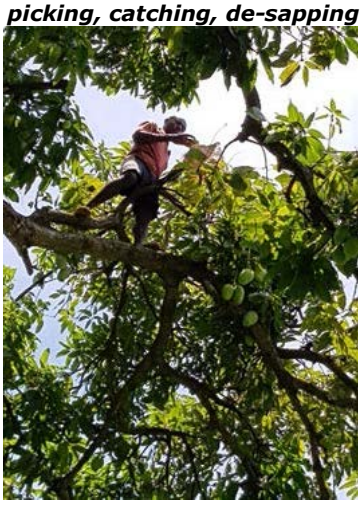
For export, preferably fruits with colour of level 2 or 3 is harvested. Too early harvest gives a risk that the fruit keeps well but develops less taste when ripening later. Too late gives good taste but shortens shelf life.

The mango trees in the project area are usually old and very high (up to 15 meter). Harvest takes place by climbing the tree and ripping of the fruit with a bag on a log stick. This leads to an inefficient harvesting system with dangerous working conditions.

Photograph 11: Mangoes in tree, harvesting tool, colour scale



Photograph 12: Mango harvest, picking, catching, de-sapping



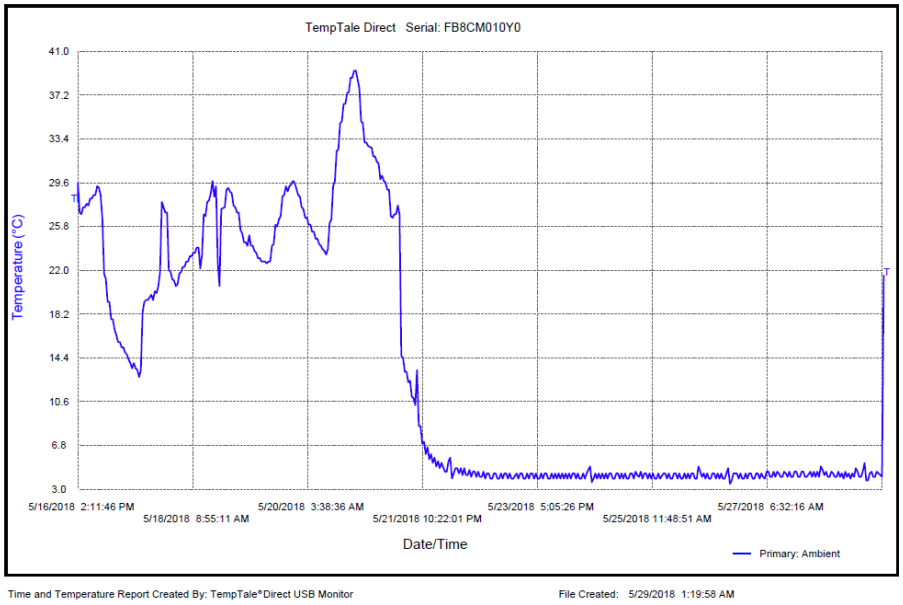

3.2 Data collected

Box 1, Mango:

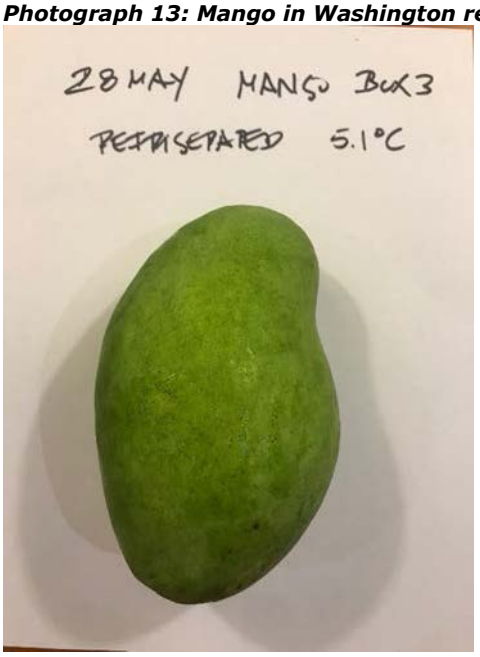
Figure 5: Label box 1 mango

code: 2001
recipient: Washington, E. Duch

Graph 5: Temperature graph Box 1 mango



Photograph 13: Mango in Washington refrigerated



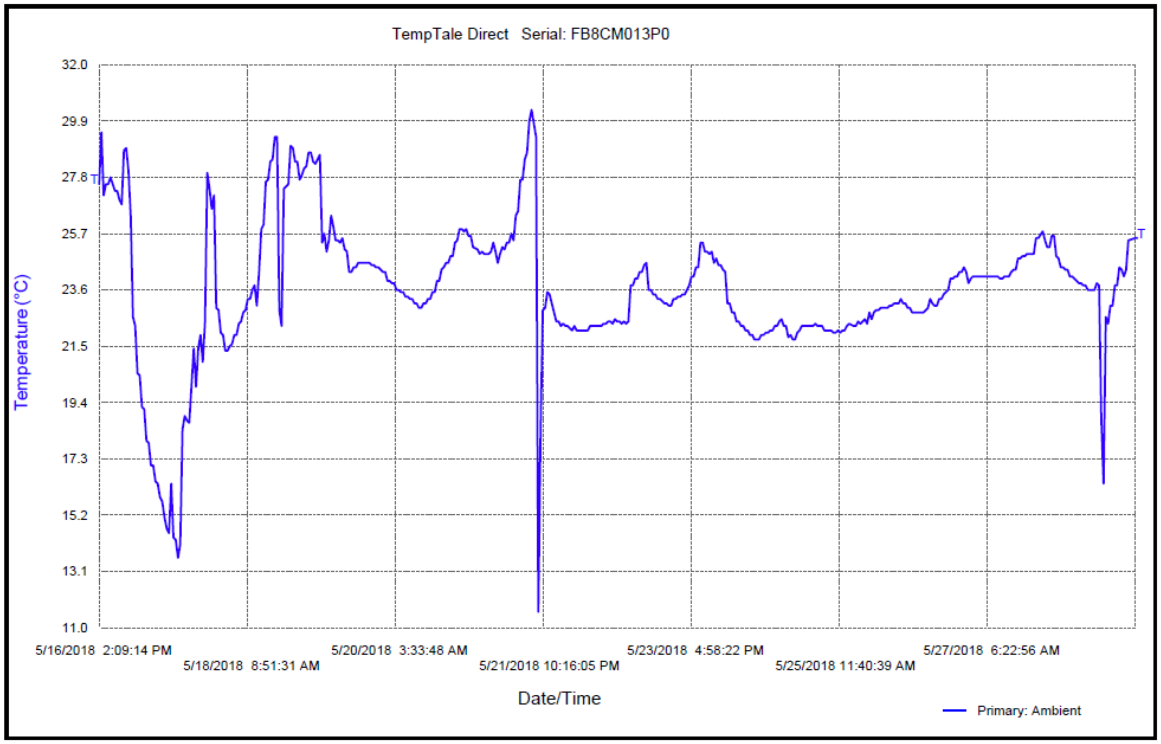
Despite the high temperatures during transport, even surpassing the 30C upper limit, the mangoes arrived in good shape. Also the storage in a refrigerator at lower then recommended temperature did not cause chilling injury nor negatively influenced ripening.

Box 2, Mango:

Figure 6: Label box 2 mango

code: 2002
recipient: Washington, E. Duch

Graph 6: Temperature graph Box 2 mango



Photograph 14: Mango Washington room temperature

Despite the high temperatures during transport, even surpassing the 30C upper limit, the mangoes arrived in good shape and ripened well during a week at room temperature

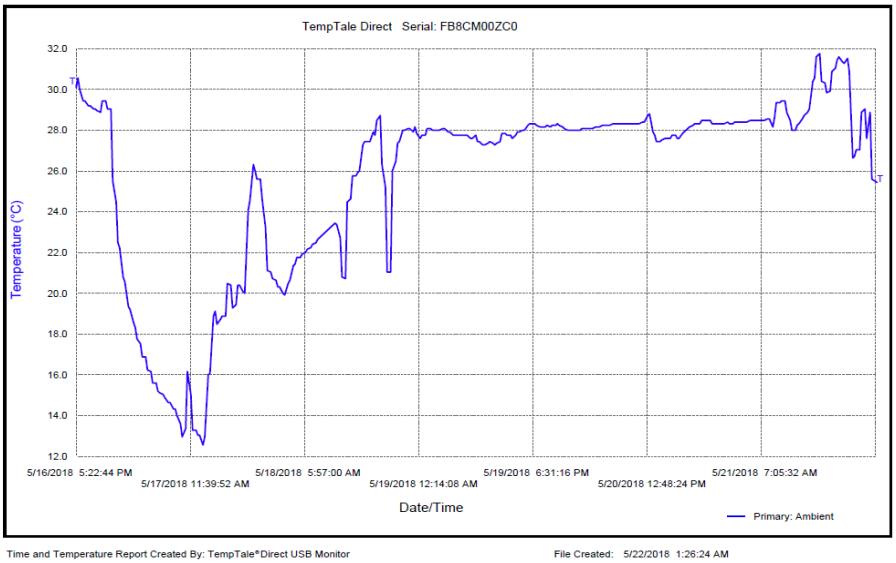
Note: Box 3 is Box 2 mango

Box 3, Mango:

Figure 7: Label box 3 mango

code: 2003
recipient: Miami, G. Ferrer

Graph 7: Temperature graph Box 3 mango



Photograph 15: Mango in Miami upon arrival

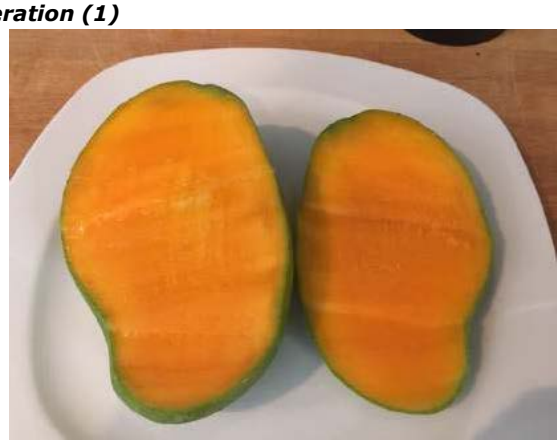
3 mangoes were taken from the box and kept at room temperature. The rest was stored in a fridge. The room temperature set in the house was 76 Fahrenheit (24.4 ºC). Outside the temperatures are always higher at this time of the year.

After 3 days one was cut open and it was like this, on May 24, 2018. The taste was good, a little too ripe and sweet and with a lot of fibre.

Photograph 16: Mangoes in Miami after 3 days room temp

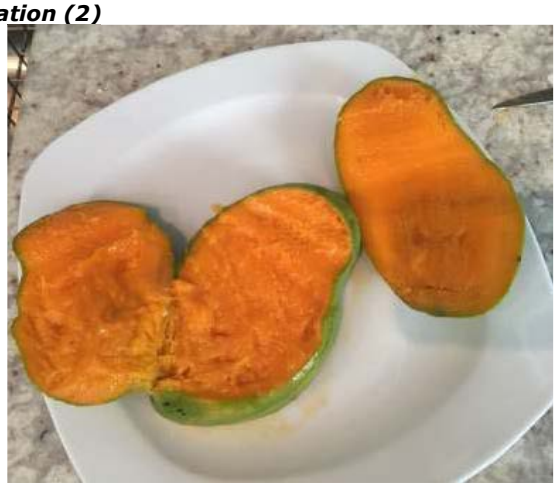

On May 30, 2018, 2 mangoes were cut open again (all from the fridge). One was perfect, see below: It was juicy, sweet, perfectly ripe and good texture.

Photograph 17: Mangoes in Miami after refrigeration (1)

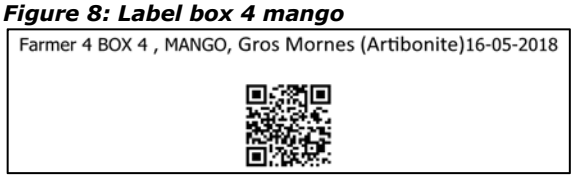
However, the other one was too ripe. Again this time the pulp is very fibrous and it is difficult to remove from the bone. It was too ripe and too sweet. See below.

Photograph 18: Mangoes in Miami after refrigeration (2)

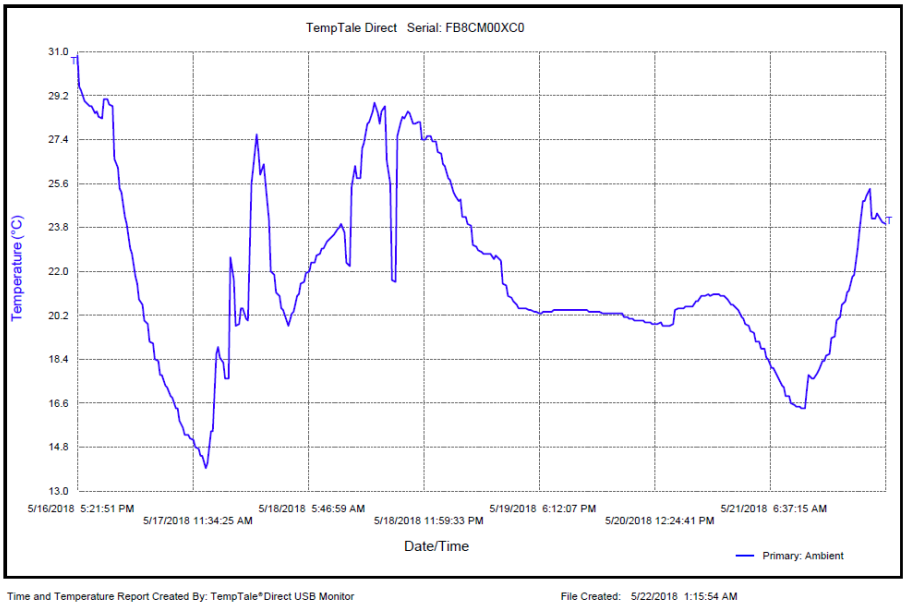
Box 4, Mango:

Figure 8: Label box 4 mango



code: 2004
recipient: Toronto, S. Kim

Graph 8: Temperature graph Box 4 mango

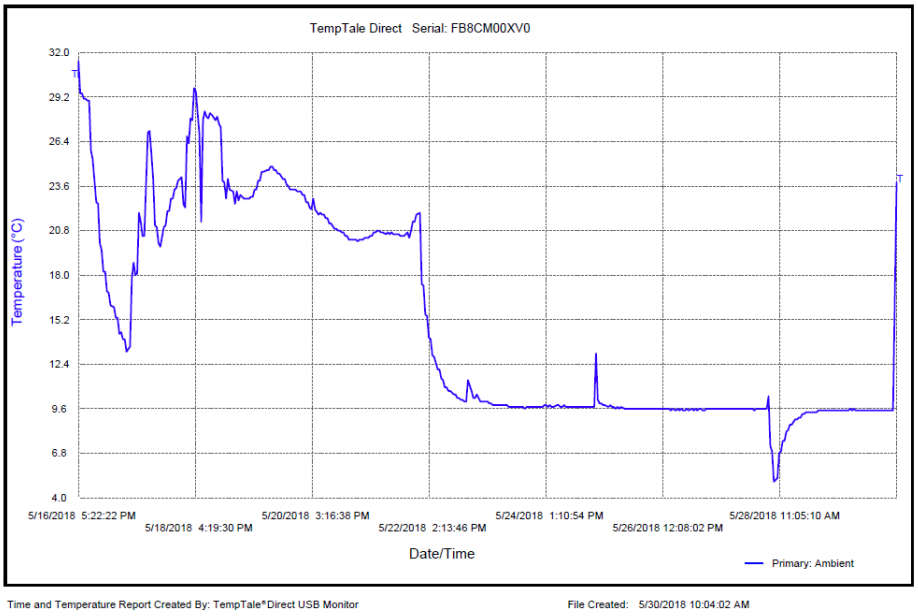


Box 5, Mango:

Figure 9: Label box 5 mango

code: 2005
recipient: Wageningen, R. Oostewechel

Graph 9: Temperature graph Box 5 mango

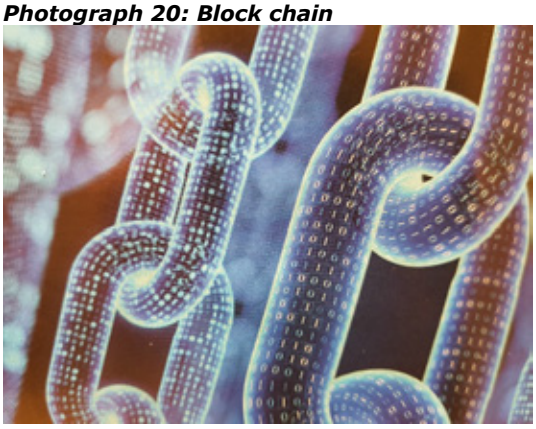


Photograph 19: Mangoes in Wageningen

The mangoes arrived well in Wageningen. They kept well until 1st of June after which they became to ripe even in cold storage. Also the black spots (anthracnose) became too much. They were still eatable on 6 June but not marketable.

4 Distributed ledger technology

Photograph 20: Block chain



Source: Air France Journal

Mr. Luis Domenech at IFC in Washington made a mock presentation about the shipment of mango to DC, see Annex 2 and presentation in link below:
https://public.tableau.com/profile/luis.domenech#!/vizhome/MangoxPhonetest4/Test4?publish=yes

Scanning the QR code on the box (see copy below) will provide the customer with information of the fruits inside:

- Overview of price build-up
- Name & photograph of the farmer
- Location of the tree
- Timeline from tree to retail (farmer, harvester, transport, packer, shipper, retail)
- (For each link: address, date, temperature, costs)
- Temperature graph

This presentation was based on data collected in the test as follows:

Table 1: Test data per farmer

producer	box	Address	Lable	harvest	number fruit harvestred	Ripeness indication	fruit cost (US$)	harvesting costs (US$)	total cost at grove (US$)	gross cost per fruit (US$)
farmer 1	1	Mr. Emiliano Duch, 3406 Raymond Street, Chevy Chase, MD 20815, USA, Tel: 301-841-7706	Farmer 1 BOX 1 , Avocado, Las Cahobas (Centre)15-05-2018	harvest : 15-05-2018; 12.00 -12.40 h. Fruit temp 32,8 C	23	2	13.30	2.00	15.30	0.67
farmer 1	2	Mw. Gloria Ferrer, 10480 SW 70 Avenue, Pinecrest FL 33156, USA, Tel : 301-841-7706	Farmer 1 BOX 2 , Avocado, Las Cahobas (Centre)15-05-2018	harvest : 15-05-2018; 12.00 -12.40 h. Fruit temp 32,8 C	23	2	13.30	2.00	15.30	0.67
farmer 2	3	Mw. Sharon Kim, 10 Hardcroft Road, Toronto, ON M652V9, Canada , Tel 406-416-618-2797	Farmer 2 BOX 3 , Avocado, Las Cahobas (Centre)15-05-2018	harvest : 15-05-2018; 13.35 - 14.20 h. Fruit temp 33,9 C	32	3	10.00	2.00	12.00	0.38
farmer 2	4	Wageningen University & Research, Attn. Mr. R. Oostewechel, Bornse Weilanden 9 (Building 118), Wageningen, The Netherlands, Tel: 0317-489717	Farmer 2 BOX 4 , Avocado, Las Cahobas (Centre)15-05-2018	harvest : 15-05-2018; 13.35 - 14.20 h. Fruit temp 33,9 C	32	3	10.00	2.00	12.00	0.38
farmer 3	1	Mr. Emiliano Duch, 3406 Raymond Street, Chevy Chase, MD 20815, USA, Tel: 301-841-7706	Farmer 3 BOX 1 , MANGO, Gros Mornes (Artibonite)16-05-2018	harvest : 16-05-2018; 09.35 - 11.00 h. Fruit temp 26,1 C	50	 3	7.00	2.00	9.00	0.18
farmer 3	2	Mr. Emiliano Duch, 3406 Raymond Street, Chevy Chase, MD 20815, USA, Tel: 301-841-7706	Farmer 3 BOX 2 , MANGO, Gros Mornes (Artibonite)16-05-2018	harvest : 16-05-2018; 09.35 - 11.00 h. Fruit temp 26,1 C	50	 3	7.00	2.00	9.00	0.18
farmer 4	3	Mw. Gloria Ferrer, 10480 SW 70 Avenue, Pinecrest FL 33156, USA, Tel : 301-841-7706	Farmer 4 BOX 3 , MANGO, Gros Mornes (Artibonite)16-05-2018	harvest : 16-05-2018; 12.25 - 14.00 h. Fruit temp 30,6 C	48	 2	7.00	2.00	9.00	0.19
farmer 4	4	Mw. Sharon Kim, 10 Hardcroft Road, Toronto, ON M652V9, Canada , Tel 406-416-618-2797	Farmer 4 BOX 4 , MANGO, Gros Mornes (Artibonite)16-05-2018	harvest : 16-05-2018; 12.25 - 14.00 h. Fruit temp 30,6 C	48	 2	7.00	2.00	9.00	0.19
farmer 4	5	Wageningen University & Research, Attn. Mr. R. Oostewechel, Bornse Weilanden 9 (Building 118), Wageningen, The Netherlands, Tel: 0317-489717	Farmer 4 BOX 5 , MANGO, Gros Mornes (Artibonite)16-05-2018	harvest : 16-05-2018; 12.25 - 14.00 h. Fruit temp 30,6 C	48	 2	7.00	2.00	9.00	0.19

transport	storage at packhouse	Grading Packing	export quality number	% export of harvested fruit	nett cost per exported fruit (US$)	storage	Cost packing material (US$ per box)	numbr fruit per box	Cost packing material (US$ p. fruit)	tansport to DHL	fligth to Miami	Arrival
15-05-2018; 12.40 -16.00 h: Temp; 8 C	15-05-2018; 16.10 h; Temp 20,0 C	17-05-2018; 09.30-10.30; Temp 22,0 C	20	87%	0.77	17-05-2018 ; 10.30 - 13.30; Temp 14,6 C	0.78	10	0.078	17-05-2018; 13.30-15.45 h Temp 22.0 C	17-05-2018; 17.00 -20.00 h	21-05-2018
15-05-2018; 12.40 -16.00 h: Temp; 8 C	15-05-2018; 16.10 h; Temp 20,0 C	17-05-2018; 09.30-10.30; Temp 22,0 C	20	87%	0.77	17-05-2018 ; 10.30 - 13.30; Temp 14,6 C	0.78	10	0.078	17-05-2018; 13.30-15.45 h Temp 22.0 C	17-05-2018; 17.00 -20.00 h	21-05-2018
15-05-2018; 14.20 -16.00 h: Temp; 8 C	15-05-2018; 16.10 h; Temp 20,0 C	17-05-2018; 09.30-10.30; Temp 22,0 C	20	63%	0.60	17-05-2018 ; 10.30 - 13.30; Temp 14,6 C	0.78	10	0.078	17-05-2018; 13.30-15.45 h Temp 22.0 C	17-05-2018; 17.00 -20.00 h	21-05-2018
15-05-2018; 14.20 -16.00 h: Temp; 8 C	15-05-2018; 16.10 h; Temp 20,0 C	17-05-2018; 09.30-10.30; Temp 22,0 C	20	63%	0.60	17-05-2018 ; 10.30 - 13.30; Temp 14,6 C	0.78	10	0.078	17-05-2018; 13.30-15.45 h Temp 22.0 C	17-05-2018; 17.00 -20.00 h	22-05-2018
16-05-2018; 11.10 -18.00 Temp 22 C	16-05-2018 18.00 h Temp. 14,6 C	17-05-2018 11.00-13.00 Temp. 22 C	16	32%	0.56	17-05-2018 13.00-13.30 Temp. 22 C	0.78	8	0.0975	17-05-2018; 13.30-15.45 h Temp 22.0 C	17-05-2018; 17.00 -20.00 h	21-05-2018
16-05-2018; 11.10 -18.00 Temp 22 C	16-05-2018 18.00 h Temp. 14,6 C	17-05-2018 11.00-13.00 Temp. 22 C	16	32%	0.56	17-05-2018 13.00-13.30 Temp. 22 C	0.78	8	0.0975	17-05-2018; 13.30-15.45 h Temp 22.0 C	17-05-2018; 17.00 -20.00 h	21-05-2018
16-05-2018; 14.10 -18.00 Temp 22 C	16-05-2018 18.00 h Temp. 14,6 C	17-05-2018 11.00-13.00 Temp. 22 C	24	50%	0.38	17-05-2018 13.00-13.30 Temp. 22 C	0.78	8	0.0975	17-05-2018; 13.30-15.45 h Temp 22.0 C	17-05-2018; 17.00 -20.00 h	21-05-2018
16-05-2018; 14.10 -18.00 Temp 22 C	16-05-2018 18.00 h Temp. 14,6 C	17-05-2018 11.00-13.00 Temp. 22 C	24	50%	0.38	17-05-2018 13.00-13.30 Temp. 22 C	0.78	8	0.0975	17-05-2018; 13.30-15.45 h Temp 22.0 C	17-05-2018; 17.00 -20.00 h	21-05-2018
16-05-2018; 14.10 -18.00 Temp 22 C	16-05-2018 18.00 h Temp. 14,6 C	17-05-2018 11.00-13.00 Temp. 22 C	24	50%	0.38	17-05-2018 13.00-13.30 Temp. 22 C	0.78	8	0.0975	17-05-2018; 13.30-15.45 h Temp 22.0 C	17-05-2018; 17.00 -20.00 h	22-05-2018

5 Analysis and conclusions

Below a number of additional observations, analytical remarks and conclusions are presented. They complement the findings presented in the technical report (WFBR report 1804).

1. The Francis variety is still green when ripe. Mrs Ferrer in Miami was somewhat confused because she thought this variety of mangos [Francis] was similar to the one from other countries that can be found at WholeFoods that turn into yellow when ripe. See the image below.

Photograph 21: Mangoes on display in Miami retail

In Miami there are many different varieties from other countries but none is green when ripe. This is important to notice because when explaining to the final consumer it needs to be advertised as "ready to eat even green", especially because many different varieties of mangos can be found already.

2. The tests confirmed the importance for both fruits of the exact harvest moment; mature but not ripe. As those fruits clearly had a longer shelf life.

3. The test confirmed that for mango a concession can be made regarding the time limit for the fruit to be cooled down, like already included in the WFBR report. It is important to take into account the difficult logistical situation in the harvesting areas in Haiti.

4. Attention should be given to the occurrence of black spots on the fruit (anthracnose) by (1) not accepting fruits with visible defects and (2) treat the mango (with hot water).

5. Most significant in relation to shelf life seems to be the maturity at the time of harvest as those fruits that were harvested less mature, had a longer shelf-life (mango as well as avocado in Miami and Washington). Even exposure to very high temperatures did not affect these fruits too much.

6. Although the effect of cooling was not proven in this test, it still is of utmost importance for quality and shelf life

7. The test showed that storage at temperatures as low as 5.1 C (Washington) did not cause chilling injury even in mango, nor did it negatively affect the ripening process (Caution is required with drawing a conclusion as effects may be partly a sum of temperature and time). The lowest temperature limit for Francis mango as presented in the report, can therefore be a few degrees lower.

8. The test confirmed that a consumer at box level in a retail store can easily scan a QR and get information about the fruit. Additional information can be added.

9. The test confirmed, or even made us reconsider the steps in the harvesting process. It is very time consuming and the trees are very high, making the harvest difficult and not without risk.

10. The accessibility of the trees is worse than anticipated beforehand. It is often not possible to reach the grove other than by foot due to the terrain and due to the fact that the trees are often in a garden full with other crops like beans, maize, cassava, coco yam, etc.

11. Data registration is possible by mobile phone but needs special attention to make the process as easy as possible. Special attention will be needed for small batches that need to be sorted in a pack station. When the farmer remains owner of the fruit, all data regarding his batch need to be registered correctly and efficiently. This increases the cost as for each batch the line should be stopped. Also the registration must be digitalized. In the Netherlands, packers regard a 3.000 kg already as a small batch that causes extra work, half full boxes or even pallets etc. Even if the machines keep running and a marker is put with the fruits on the line to mark the change from one batch to another. In Haiti the batches might be smaller and cause more work and the farmers' ownership requires an even more precise separation of batches.
    In this context, several separate small sorting lines would probably be preferred over one big line.

12. The test confirmed the need to cooperate with a local exporter that has an extensive network and years of experience. As long as the harvesting and collection of the fruit is as complicated as currently.

13. These test results lead to the following adaptions to the technical report:
    - Limit the Service Provider to have one person in the harvesting site, to provide the boxes for de-sapping and packaging boxes (and optionally foam jackets) and start the traceability, sticking the QR codes, and controlling fruit temperatures and time to refrigerated truck. The actual harvesting team is hired by the farmer and acts under his/her responsibility (trees were too tall and risky);
    - The SP will pick up fruits at any road point, in the roads marked as viable year around in the attached map, the transport from the orchard to the road will be responsibility of the farmer (as well as carrying the empty boxes from the truck to the orchard). The maximum travel time from the orchard to the road will be 60 minutes (under shade);
    - The estimated collection week should be communicated by the farmer by phone one month ahead. A second confirmation to come to collect should be made 7 days ahead, and the SP can combine the collections and schedule anytime during the 7 days. The day will be communicated to the farmers by phone call and/or SMS;
    - The minimum amount per collection point will be 700 mangoes (50 dozens of 14), 960 avocados (80 dozens) or XXX pineapples (xx dozens);
    - The SP should have a flat rate per Kg of fruit, that includes all the above service, plus the grading, packing and shipment to an entry point in the US, including the clearing from customs, and keeping it in a refrigerated depo in the US for a week, until the broker has found a buyer. The rest of transportation to other points in US or Canada, will be charged separately to the buyer.
    - When registering the supplying farms: We would also like to identify the tree by QR and GPS, via GBDX satellite images (https://www.digitalglobe.com/platforms/gbdx);
    - When registering the supplying farms: apart from location, name, number of trees etc., additional information collection could be added in the future once the business runs well. This could then concern: the source, quality and availability of irrigation water, vulnerability to erosion, erosion type and mitigation measures if applicable, CO2 absorption and emission in the chain.

Taking into account the adaptations suggested in above, especially in point 13, the selection criteria for the SP will be the lowest price per Kg, collected and transported to a depo in the US. Always under the QC conditions specified in the tender.

Literature

WB Report No: ACS22611 (2017) Republic of Haiti DTIS Implementation. Design of a Fresh Logistics Center and Fisheries Processing Facility in Haiti. GTC04 Latin America and Caribbean

Oostewechel, R,; Y.L. Régis; J. Brouwers (2017) Technical and financial evaluation for a logistics service for the control of the cold chain in the export of fresh products between Haiti and the United States. WFBR report 1795

Oostewechel, R,; Y.L. Régis; J. Brouwers (2018) Technical design proposal report. Outline for tendering the Haitian fruit logistics cold chain design. WFBR report 1804

Annex 1: Programme technical Dry Run

Sunday 13 May

Arrival Rene Oostewechel and Jan Brouwers with AF0618 at 18.20

MCI Mrs Islande Mercier will pick up mission members and transport to hotel Servotel

phone number (509) 4889 7197

Evening: Last check on logistics: transport mission and transport refrigerated truck

Hotel: Servotel http://www.servotelhaiti.com/home/

Monday 14 May

Morning:

08.00 Breakfast YLR-RO-JB

08.45 Pick up by MCI driver

09.00 Briefing and last checks at MCI

11.00 Meeting at Perry Import – Export. Check on logistics, timing and procedures.

12.00 Travel to Centre, lunch en route (both mission team as well as small refrigerated truck)

Afternoon:

14.00 Check with SAE Centre team on procedures, material, timing and preparing harvesting Tuesday morning.

Hotel: Royal Decameron Montrouis +509 2815 0111 https://www.decameron.com/

Tuesday 15 May

Morning:

- First steps avocado harvesting, processing and transport.

Afternoon:

- Refrigerated truck travels to PaP and avocados are placed in cool store at Perry Import-Export (6-8 degree Celcius)
- Prepare with SAE Gros Morne team on procedures, material, timing and preparing mango harvesting. Meeting to be held in Gonaives with SAE Artibonite

Hotel Le Village d'Ennery +509 2227 7374 info@villagedennery.com www.levillagedennery.com

MCI and WB join for dinner in the evening and for mango trial Wednesday morning

Wednesday 16 May

Morning: First steps mango harvesting and processing, with Minister MCI and WB delegation

Afternoon: Transport to PaP

Hotel: Servotel http://www.servotelhaiti.com/home/

Thursday 17 May

Of loading mango and treatment at Perry

Placing loggers in boxes and checking proper. temperature for next step (air transport)

Transport from Perry to Airport/DHL (schedule to be fine-tuned with available flights)

16.00 Debriefing with MCI and WB. Venue: MCI office

Hotel Servotel http://www.servotelhaiti.com/home/

Friday 18 May

Public Holiday! DHL is not operational.

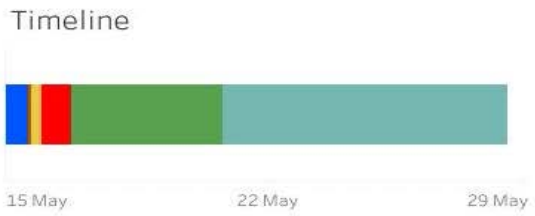
Reporting on first lessons Dry Run with reflection on recommendations for tender procedure

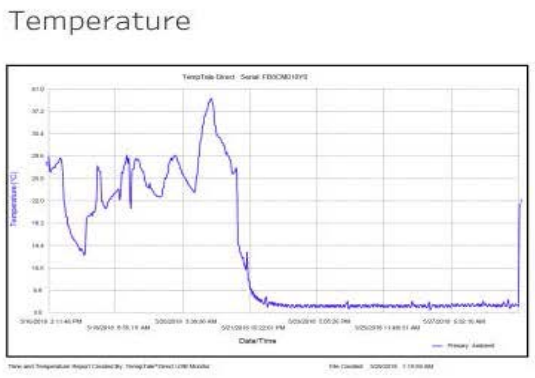
Saturday 19 May

Alternative day for transport to DHL in case it was not possible to ship on Thursday

Departure Rene Oostewechel and Jan Brouwers

Annex 2: Mock Presentation





To explore the potential of nature to improve the quality of life

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The mission of Wageningen University and Research is "To explore the potential of nature to improve the quality of life". Under the banner Wageningen University & Research, Wageningen University and the specialised research institutes of the Wageningen Research Foundation have joined forces in contributing to finding solutions to important questions in the domain of healthy food and living environment. With its roughly 30 branches, 5,000 employees and 10,000 students, Wageningen University & Research is one of the leading organisations in its domain. The unique Wageningen approach lies in its integrated approach to issues and the collaboration between different disciplines.